

CLAIMS

What is claimed is:

1. A method of electrolytically plating a layer of metal on the internal surface of an opening within a substrate, said method comprising:

substantially immersing a substrate having an opening therein within an electroplating bath containing ions of a metal to be deposited onto the internal surface of said opening; and

passing an electric current through said bath wherein said current includes modulated forward and reverse pulses, selected ones of said forward and/or reverse pulses followed by a pause in said electric current, so as to deposit a substantially uniform layer of said metal on said internal surface of said opening.
2. The method of claim 1 wherein said substrate is a dielectric substrate for use in a printed circuit board and said opening is a conductive thru-hole.
3. The method of claim 2 wherein said dielectric substrate is a material selected from the group consisting of fiberglass-reinforced epoxy resin, polytetrafluoroethylene, polyimide, polyamide, cyanate resin, photoimageable materials and combinations thereof.
4. The method of claim 3 wherein said metal is copper.
5. The method of claim 1 wherein said forward pulses each have a pulse width within the range of from about 40 to about 140 milliseconds.
6. The method of claim 5 wherein said reverse pulses each have a pulse width within the range of from about 2 to about 8 milliseconds.

7. The method of claim 6 wherein said pause in said electric current following said selected ones of said forward and/or reverse pulses is within the range of from about 0.1 to about 1.0 millisecond.
8. The method of claim 7 wherein the ratio of times of said forward pulse to said reverse pulse to said pause is within the range of from about 40:4:1 to about 400:20:1.
9. The method of claim 1 wherein each of the pairs of said forward and reverse pulses are provided for an average current density of from about 8 to about 15 amperes per square foot.
10. The method of claim 9 wherein the ratio of said current densities of said forward pulses to said reverse pulses is within the range of from about 1:2.5 to about 1:3.5.
11. The method of claim 1 wherein said electroplating bath further includes organic brighteners, carriers and/or levelers.
12. The method of claim 1 wherein said electroplating bath is an acid bath composition including from about 10 to about 15 grams per liter of copper.
13. The method of claim 12 wherein said acid bath composition includes from about 230 to about 270 grams per liter of acid.
14. The method of claim 12 wherein said acid is sulfuric acid.
15. The method of claim 1 wherein said substrate has a predetermined thickness and said opening has a predetermined diameter, the ratio of said predetermined thickness of said substrate to said predetermined diameter of said opening being within the range of from about 8:1 to about 25:1.

16. A printed circuit board comprising:
- a dielectric substrate having a predetermined thickness; and
- at least one conductive, substantially uniformly plated opening within said substrate, said plated opening formed using an electrolytic plating operation in which an electric current including modulated forward and reverse pulses is passed through a bath including ions of the metal to form said plating therein with selected ones of said forward and/or reverse pulses followed by a pause in said electric current, so as to deposit a substantially uniform plating of said metal on the internal surface of said opening while said dielectric substrate is substantially immersed within said bath .
17. The printed circuit board of claim 16 wherein said dielectric substrate is of a dielectric material selected from the group consisting of fiberglass-reinforced epoxy resin, polytetrafluoroethylene, polyimide, polyamide, cyanate resin, photoimageable materials and combinations thereof.
18. The printed circuit board of claim 16 wherein said metal forming said conductive, substantially uniformly plated opening comprises copper.